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Carbon Monoxide Study
Boise, Idaho

November 25 -
December 22, 1977

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Part 1. CARBON MONOXIDE STUDY - BOISE, IDAHO
NOVEMBER 25 - DECEMBER 22, 1977
EXECUTIVE SUMMARY

PREPARED BY

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SURVEILLANCE AND ANALYSIS DIVISION

FOR

AIR PROGRAMS BRANCH

AIR AND HAZARDOUS MATERIALS DIVISION

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DECEMBER 1978

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PREFACE

Under the Clean Air Act of 1970 the U.S. Environmental Protection Agency has established standards for carbon monoxide in air external to buildings to which the public has access. In a number of cities, including Boise, these standards have not yet been attained. Plans to achieve the standards are now required under the Clean Air Act Amendments of 1977 (PL 95-95). It is hoped that the material presented in this report will assist in achieving progress towards attainment of the standards.

ACKNOWLEDGMENTS

We gratefully acknowledge the assistance of many members of the Idaho State Department of Health and Welfare, the Idaho Transportation Department, and Ada Planning Association in providing information for the planning and conduct of this study. We especially wish to thank the Idaho State Department of Health and Welfare for providing facilities to establish a field laboratory in Boise for use by the EPA contractor. A number of individuals gave freely of their time and information and their efforts contributed materially to this study, though they are not, of course, responsible for any errors herein. These people include: Richard Johnson and Doss Terrel (IDHW), John Hamrick, Keith Longnecker, and Lee Hatch (ITD); Ervin Olen, Jr. and Robert Minter, Jr. (APA).

Several firms and institutions graciously permitted installation of equipment on their premises and without their cooperation, portions of this study could not have been conducted. Our sincere thanks go to: St. Luke's Hospital, Idan-Ha Hotel, Sexty's Jewelers, David's Fabrics, Singer's, Falk's, and Boise State University.

Finally, we express gratitude to many members of the EPA staff for guidance, encouragement, and assistance.

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Abbreviations and Symbols

AM - The four-hour* interval from 10:00 a.m.* to 2:00 p.m.*

PM - The four-hour* interval from 2:00 p.m.* to 6:00 p.m.*

AVC - The eight-hour* average CO concentration for the 10:00 a.m.* to 6:00 p.m.* sample collected at an EPA special study site (average calculated from AM and PM concentrations)

AVS - The eight-hour average from 10:00 a.m. to 6:00 p.m. of continuous non-dispersive infra-red measurements at the permanent monitor

ODD - The permanent monitor operated by the State at the Odd Fellows Hall at 115½ Ninth Street

n/o - north of as in "Ninth n/o Idaho"

w/o - west of as in "Idaho w/o Eighth"

Exceedence of Standard** - An eight-hour average CO concentration exceeding 9.0 ppm

Violation of Standard - The second eight-hour, non-overlapping, running average in a year to exceed 9.0 ppm

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* plus or minus fifteen minutes

** This report discusses only the standard for the eight-hour average and does not discuss the standard for one-hour average CO concentrations.

INTRODUCTION

Frequent violations of the national ambient air quality standard* for carbon monoxide (CO) have occurred at the only continuous monitor in downtown Boise which is operated at 115½ Ninth Street by the Idaho Department of Health and Welfare (Figure 1). However, more information on the severity of the CO problem and its geographical extent was desired to assist in selection of candidate sites for additional routine monitoring and to examine the representativeness of the existing site. The levels of CO encountered by pedestrians in the city and indoor occupants were also of interest. Therefore, a study was planned and conducted to address these needs. This report (Part 1) presents the major results and conclusions. A more detailed description of the methods, additional discussion and analysis and the data obtained in this study appear in a separate volume (Part 2).

SUMMARY

In 1977, a 20-day study involving forty outdoor sites, six indoor sites, and two pedestrian walking routes was conducted in Boise, Idaho during

---

* Federal Register, 42 FR8186, April 30, 1971. The standard for carbon monoxide addresses two averaging periods. Eight-hour average CO concentrations shall not exceed 9 ppm more than once per year. One-hour average CO concentrations shall not exceed 35 ppm more than once per year.

November-December, the season when high carbon monoxide levels frequently occur. The purpose of this study was to obtain additional data regarding the magnitude and spatial extent of the carbon monoxide problem, the representativeness of the only permanent monitor in the central business district, and to assist in selection of candidate sites for routine monitoring. On each week-day, four-hour bag samples were collected from about 10:00 a.m. to 2:00 p.m. (AM sample) and from about 2:00 p.m. to 6:00 p.m. (PM sample) at 33 of the outdoor sites and two of the indoor sites. In addition, bag samples of air were collected on two pedestrian walking routes over two to four hours during the AM and PM periods.

Data are summarized in bar charts, which show the measurement distribution for each site or for each day of the study period; in histogram-maps showing the spatial distribution of carbon monoxide; and in tables. Results from the study sites were compared in several ways with data from the permanent monitor. Comparisons were also made between study sites along the same corridor, between indoor sites and adjacent outdoor sites, and between the two pedestrian routes. Eight-hour averages were compared with the 9.0 ppm eight-hour standard.

The study results indicate that the carbon monoxide problem is widespread and not restricted to the downtown commercial district. The magnitude of the problem may be somewhat greater than shown by data from the permanent monitor. The permanent monitor was generally representative of the higher but not the highest concentrations. Even higher concentrations and more frequent exceedences of the standard occurred on Idaho Street and Main

Street as well as at a few other sites. Exceedences occurred at other locations and were more than 1.5 to 3 times greater than at the permanent monitor when no exceedences were noted at the permanent monitor. Increases in carbon monoxide at outdoor sites were frequently reflected by increases at indoor sites. Pedestrians and some of the indoor population were exposed to concentrations above the standard.

Future monitoring should address the development of control strategies (short-term) and then track progress towards achievement of the ambient air quality standards (long-term). Planning for such studies should consider the need for related data on traffic characteristics coupled with meteorological data.

CONCLUSIONS AND RECOMMENDATIONS

The major conclusions of a 20-day study conducted in Boise during about 10:00 a.m. to 6:00 p.m. on week-days of November-December 1977 are:

1. The magnitude of the carbon monoxide problem was somewhat greater than indicated by the permanent monitor.

   - For nine study sites, (1, 10A, 11, 13, 17, 18, 20, 24, and 32) the maximum 10:00 a.m. to 6:00 p.m. eight-hour average exceeded the highest observed at the permanent monitor (13.7 ppm) during the study period.

- The highest eight-hour average (17.2 ppm) and most frequent exceedences of the 9.0 ppm standard (70% of the study days) were observed at site 32 on Idaho Street west of Eighth Street which most often had the highest eight-hour average of all sites (9 of the 20 days).

2. The spatial extent of the problem encompasses not only the downtown commercial district but also locations along traffic corridors outside the core area.

- When higher concentrations were observed in the core area, elevated CO levels also occurred elsewhere.

- Altogether about 70% of the study sites (28 out of 40) experienced one or more days when the eight-hour average exceeded the 9.0 ppm eight-hour standard. (A total of nineteen sites experienced two or more days).

3. The permanent monitor was generally representative of the higher concentrations but did not represent the highest concentrations or frequency of exceedences within the study area.

- On every day but one, the eight-hour concentration at the state site was exceeded at one or more study sites.

- During the survey, the second-highest eight-hour average for 10:00 a.m. to 6:00 p.m. at the state site (10.8 ppm) was nearly equalled or exceeded at a total of fourteen sites including three in the same block. At four sites (10A, 11, 17, and 32), concentrations were more than 2 ppm greater.

- On 95% of the study days (19 out of 20) the eight-hour standard was exceeded at one or more sites. Exceedences at the state site occurred on 47% (9 out of 19) of the sampled days.

- Eight-hour concentrations above the standard were observed at other locations and were up to three times greater than at the permanent monitor when no exceedence was noted at the permanent monitor.

- When concentrations exceeded the standard at the permanent monitor they were also exceeded at other locations.

4. Changes in CO concentrations at outdoor sites frequently coincided with changes in CO concentrations at indoor sites, but the relationship between indoor and outdoor values was not constant.

   - Concentrations were usually lower indoors than at the adjacent outdoor site.

   - Indoors, the eight-hour average concentration of carbon monoxide exceeded 9.0 ppm at times.

5. Pedestrians were exposed to eight-hour average CO concentrations exceeding the standard at times.

   - For sampling periods between two to four hours, concentrations ranged from 3.9 ppm to 14 ppm.

   - For nearly sequential sampling periods totalling seven or more hours, averages were equal to or above 9.0 ppm on four days.

It is recommended that:

1. The carbon monoxide problem in Boise be considered a widespread problem.

2. Increased local source emissions be avoided in areas where violations have been observed unless a reduction in the background concentrations which is at least sufficient to offset the increase can be demonstrated.

3. Concentrations at the permanent monitor above 9.0 ppm be considered as indicative of concentrations equally high and very likely higher elsewhere in the study area. (Note that concentrations at the permanent monitor below 9.0 ppm do not mean that air quality standards are being met throughout the study area.)

4. A site on Idaho Street (site 32 or 10A) be considered as a candidate site to represent carbon monoxide concentrations in downtown Boise for

routine ambient air quality monitoring or for short-term monitoring during the late fall and winter season, (November-December).

5. Planning for future studies to aid development of control strategies and track progress towards attainment of the standard should consider the need for related data on traffic and meteorological characteristics.

METHOD OF STUDY

Forty outdoor sites (Figure 1 and Table 1) were selected after a review of traffic characteristics, potential population exposure, and planning for the Boise downtown area. Traffic volumes were a significant factor in the selection of many sites because the motor vehicle is by far the major source of carbon monoxide in Boise. However, locations where high CO from idling vehicles might occur in situations, such as entrances or exits from large parking lots, were deliberately avoided. At each site, the sample inlet was about 3½ meters above the sidewalk, more than 10 meters from an intersection, and more than 2 meters from a vertical wall. Most samples were a little over one meter from the street curb; two were at much greater distances.

Each week-day, air was collected into a bag during two sequential periods (about 10:00 a.m. to 2:00 p.m. and about 2:00 p.m. to 6:00 p.m.) so that an eight-hour average could be calculated for comparison with the national ambient air quality standard of 9.0 ppm which is not to be exceeded more

than once per year. Samples were obtained during November 25 through December 22, 1977, on week-days from about 10:00 a.m. to 6:00 p.m. because this period of the day seemed most likely to have high carbon monoxide levels based on data from the permanent monitor (Figure 2). This appeared to be true during the survey since the daily maximum eight-hour average at the state site was within 1 ppm of the 10:00 a.m. to 6:00 p.m. average on all but four days of the study. Carbon monoxide in the study samples was analyzed by an electrochemical oxidation method. Continuous analysis of air at the indoor sites (in addition to bag sampling indoors and at the adjacent outdoor site) monitored the daily pattern of indoor carbon monoxide levels.

Indoor sites representing exposure situations in downtown buildings within a few blocks of the permanent monitor included three small retail shops, a hotel, and a large department store. A hospital site about 0.8 mile east of the permanent monitor was also sampled. At all locations, care was taken to avoid non-vehicle sources of carbon monoxide such as tobacco smoke in the immediate vicinity of the sampler or fuel combustion from building heating systems. The nearest adjacent outdoor site was the basis for comparison.

RESULTS AND DISCUSSION

Outdoor Sites

The relative severity of the carbon monoxide problem at various outdoor sites during the selected time period is indicated by several measures. Maximum and second-highest eight-hour averages, the frequency of exceedences observed at each site and maximum four-hour AM (10:00 a.m. to 2:00 p.m.) and

FIGURE 1

Boise Carbon Monoxide Study
Location of EPA Sampling Sites
11/25/77 to 12/22/77

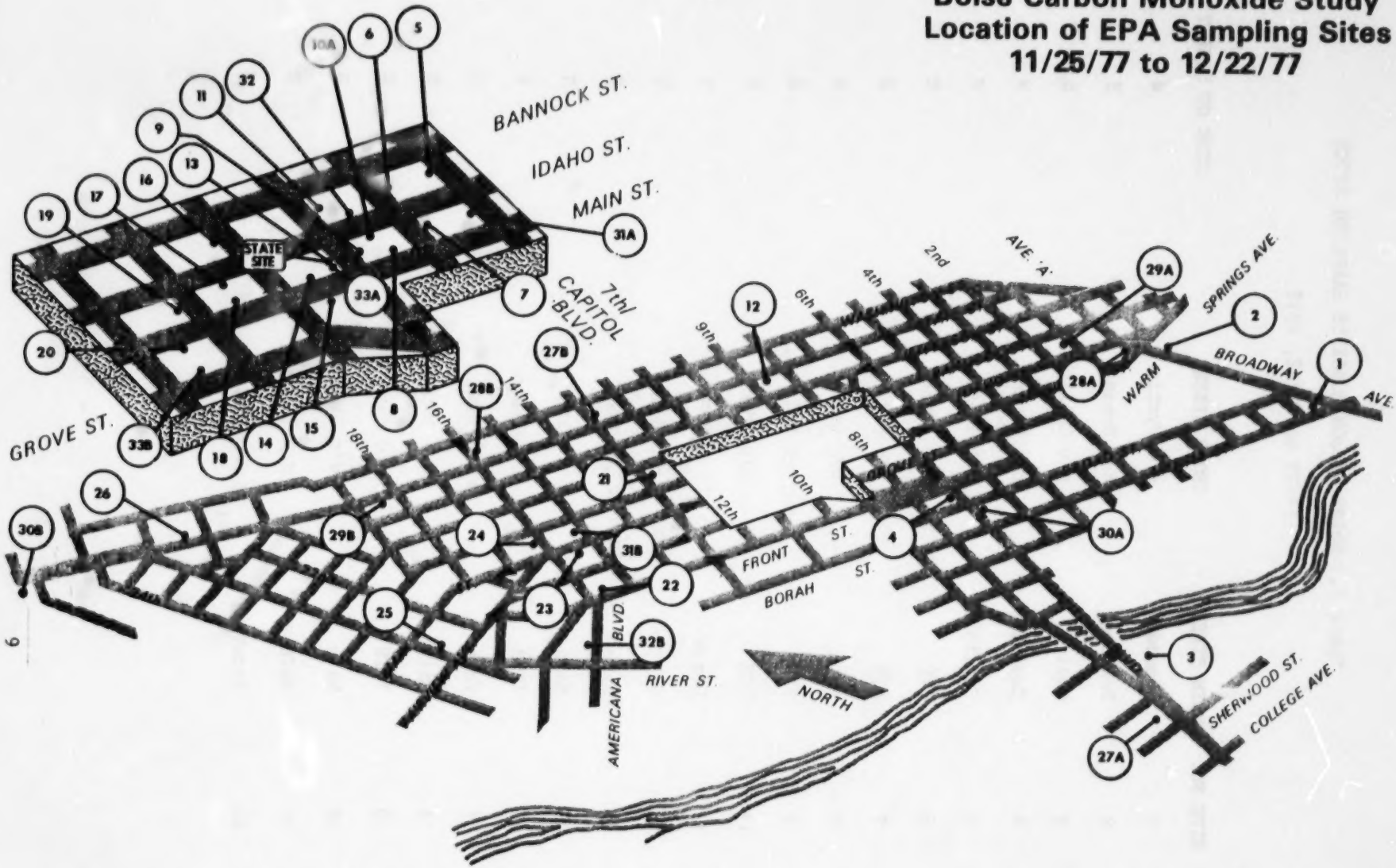


Table 1. BOISE CARBON MONOXIDE SAMPLING SITES

11/25 to 12/22, 1977

SITE NO.	MAIN STREET	CROSS STREET	SIDE OF STREET
1	Broadway	n/o Myrtle	W
2	Broadway	n/o Broad	E
3	Capitol	n/o College	E
4	Capitol	n/o Broad	W
5	Capitol	n/o Idaho	W
6	8TH	n/o Idaho	E
7	8TH	n/o Main	E
8	Main	w/o 8TH	N
9	9TH	n/o Main	E
11	9TH	n/o Idaho	E
12	State	w/o 8TH	S
13	9TH	n/o Main	W
14	Main	w/o 9TH	N
15	Main	w/o 9th	S
16	10TH	n/o Idaho	W
17	Idaho	w/o 10th	S
18	Main	w/o 10th	N
19	11TH	n/o Main	W
20	Main	w/o 11th	S
21	13TH	n/o Idaho	E
22	Front	w/o 15th	N

Table 1 (cont'd). BOISE CARBON MONOXIDE SAMPLING SITES

11/25 to 12/22, 1977

SITE NO.	MAIN STREET	CROSS STREET	SIDE OF STREET
23	Main	w/o 15TH	S
24	16TH	n/o Main	W
25	23RD	n/o Fairview	E
26	State	w/o 22nd	N
32	Idaho	w/o 8TH	N
10A	Idaho	w/o 8TH	S
27A	Capitol	n/o College*	W
27B	13TH	n/o State	E
28A	Main	w/o Broadway	N
28B	16TH	n/o State	E
29A	1ST	n/o Idaho	W
29B	State	w/o 18TH	S
30A	Capitol	n/o Myrtle	E
30B	State	w/o 25TH	S
31A	Capital	n/o Main	W
31B	15TH	n/o Main	W
32B	16TH	n/o River Road	W
33A	9TH	n/o Main	W
33B	Grove	w/o 11TH	N

* Actually n/o Sherwood

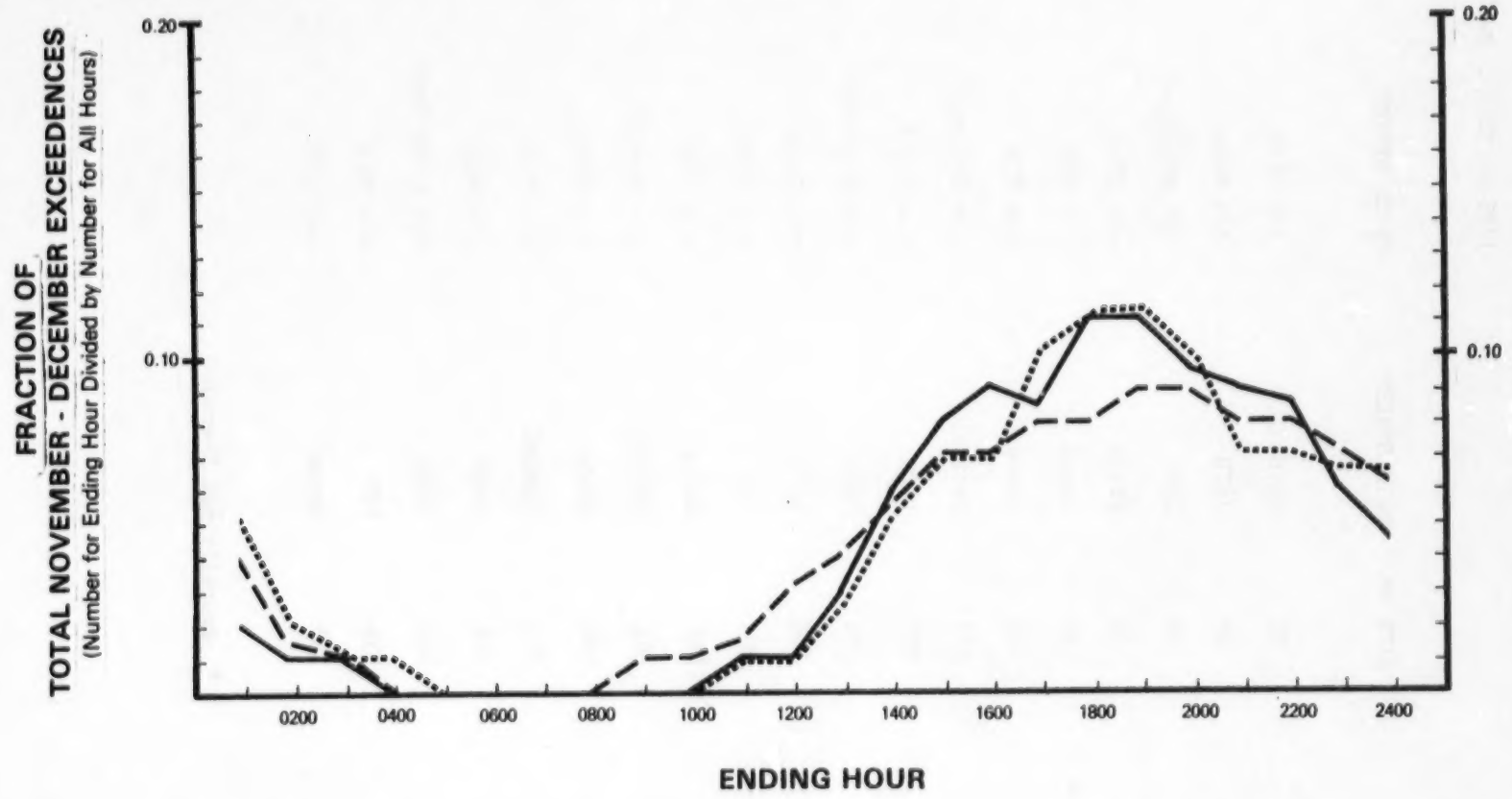
Figure 2

Boise Carbon Monoxide
State Site* Data Summary
For the November - December
Periods in 1975, 1976 and 1977

*Located at 116½ N. 9th (Odd Fellows Building)

1975 Data
1976 Data
1977 Data

Figure
Time Distribution of 8-Hour Averages Over 9.0 ppm
During November - December
(By Ending Hour)



PM (2:00 p.m. to 6:00 p.m.) averages in Table 2 may be compared with measured values at the state site. Data distributions for each site's eight-hour (10:00 a.m. to 6:00 p.m.) averages may be compared in Figure 3. Figures 4, 5, and 6 illustrate the spatial variation of the data in Table 2 on maps of Boise.

In general, the lowest values occurred at site 3 on the Boise State University campus which was the farthest from any roadway (about 192 feet east of Capitol Boulevard). The nearest roadway's contribution may have been relatively less here and thus more indicative of the varying background level of carbon monoxide.

Depending on the purpose of the analysis, different measures are appropriate for examination of the representativeness of the existing permanent monitor. Day-by-day similarities are not required to compare the necessary reduction of carbon monoxide levels implied by data from two different sites. The relationships between data at the state site and at other sites are not necessarily the same from day-to-day. Because attainment of the national ambient air quality standard will depend on developing and carrying out plans to reduce existing CO levels, it is useful to know whether or not the higher CO levels are similar at sites when measurements are taken over an extended period. Therefore, the maximum eight-hour average concentration and the frequency with which it exceeded the 9.0 ppm standard at each site are appropriate measures for comparison.

Table 2. Maximum Values from Forty Sites and the Permanent Monitor
Carbon Monoxide in ppm

Site	Maximum AM 10 AM-2 PM	Maximum PM 2 PM-6 PM	Maximum AVC 10 AM-6 PM	% AVC[1] GT 9.0	Ratio[2]	Date of Maximum AVC	Second-Hi AVC	Second Ratio[3]	Date of Second-Hi
1	12.9	16.5	14.7	60	1.4	12/02	12.6	0.9	12/22
2	10.9	8.9	9.0	0	1.0	11/25	7.7	0.6	12/22
3	5.0	4.5	4.8	0	0.5	11/25	4.2	0.4	12/02
4	9.0	10.0	9.5	5	0.9	12/02	6.9	1.3	12/12
5	11.5	15.5	13.5	15	1.3	12/02	11.8	0.9	12/22
6	11.0	11.0	10.5	10	1.0	12/02	9.4	1.5	12/06
7	9.2	12.8	8.4	0	0.8	11/30	8.1	1.6	12/12
8	12.0	16.0	13.0	8	1.5	11/25	9.0	0.7	12/22
9	14.2	13.3	13.6	35	1.3	12/02	11.9	1.9	12/06
10A*	13.5	20.6	15.9	50	1.5	12/02	13.2	1.3	12/05
11	13.2	18.0	15.6	44	1.5	12/02	13.3	2.2	12/06
12	6.3	12.9	9.5	6	0.9	12/02	8.6	1.0	11/25
13	15.1	15.2	14.2	56	1.0	12/22	12.4	1.1	12/19
14	12.1	11.5	11.2	6	1.3	11/25	7.9	0.7	12/02
15	8.0	7.5	7.6	0	0.6	12/22	7.5	0.7	11/30
16	10.0	14.0	9.9	11	0.9	12/02	9.4	0.7	12/22
17	13.9	16.5	15.2	19	1.5	12/02	13.6	1.5	11/25
18	15.6	14.9	15.3	37	1.5	12/02	12.1	1.4	11/25
19	11.3	13.1	12.1	25	1.2	12/02	10.2	1.2	11/25
20	16.5	13.5	13.8	37	1.3	12/02	11.5	1.9	12/06
21	9.0	11.2	9.9	5	0.9	12/02	8.4	--	12/01
22	10.2	12.0	11.1	10	1.1	12/02	9.1	1.0	11/25
23	14.1	11.8	13.0	18	--	12/01	11.6	1.1	12/02

(continued)

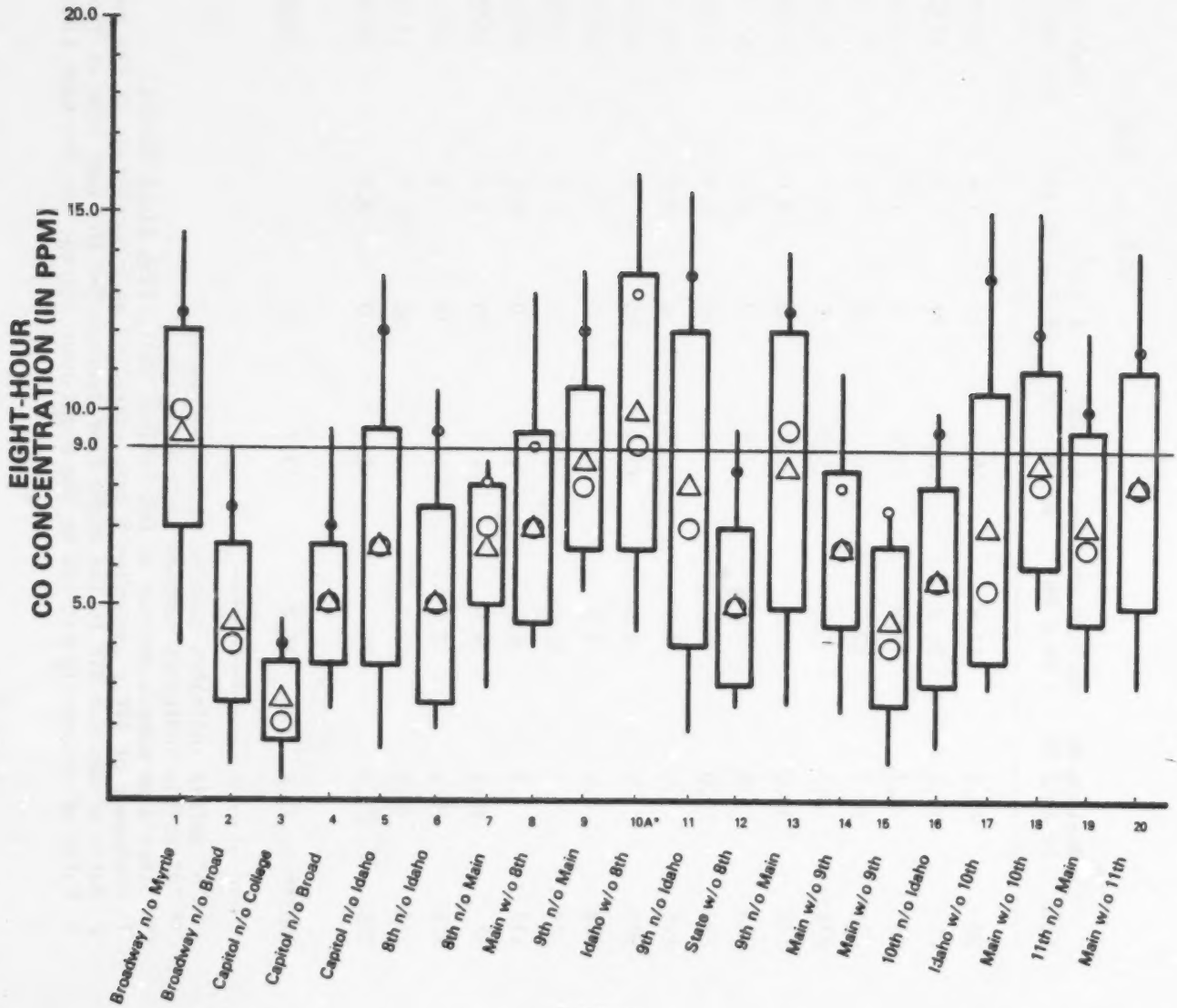
Table 2. (con't)

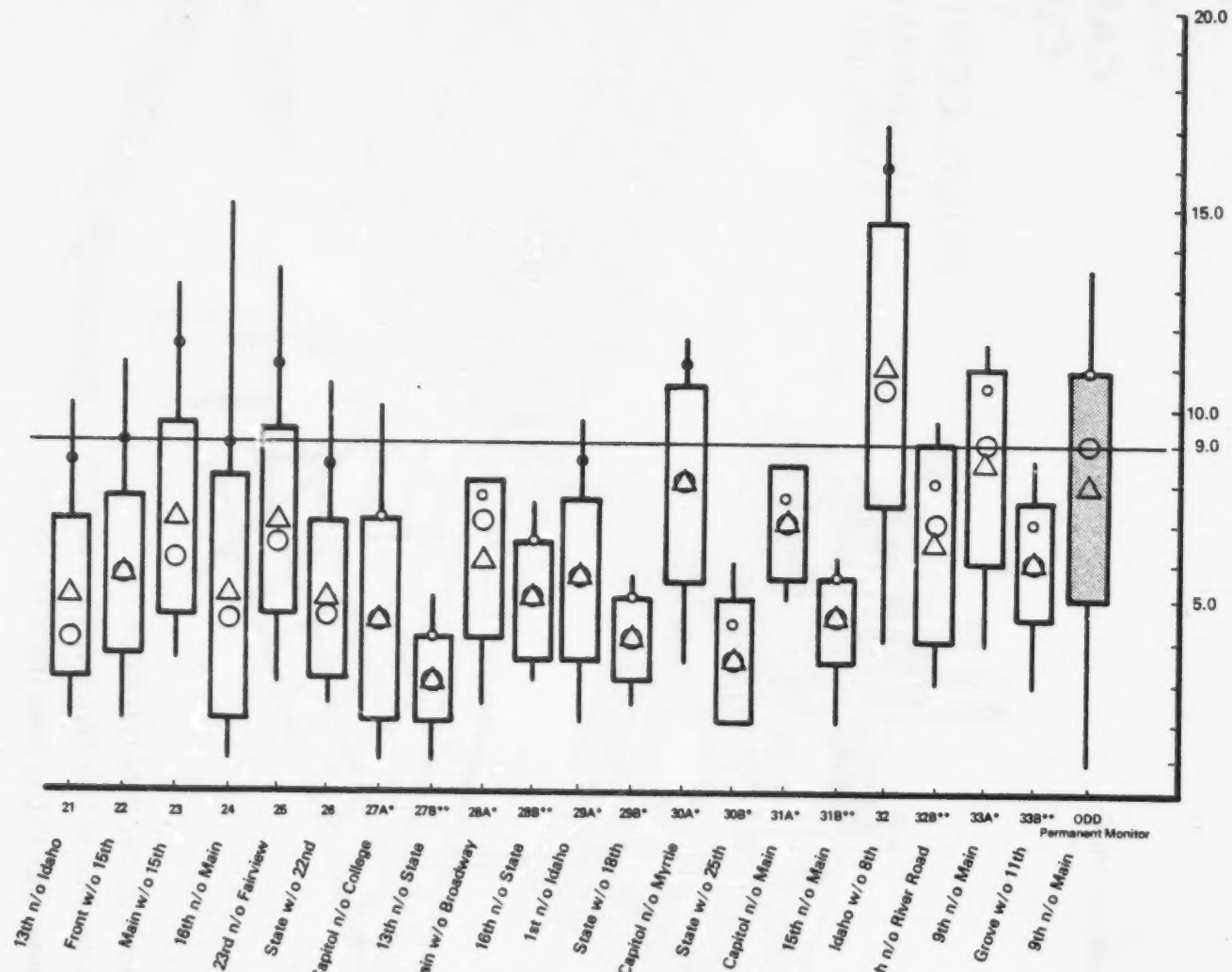
Site	Maximum AM 10 AM-2 PM	Maximum PM 2 PM-6 PM	Maximum AVC 10 AM-6 PM	% AVC[1] GT 9.0	Ratio[2]	Date of Maximum AVC	Second-Hi AVC	Second Ratio[3]	Date of Second-Hi
24	12.6	17.5	15.1	10	1.4	12/02	9.1	1.5	12/06
25	11.0	15.8	13.4	11	1.3	12/02	11.0	1.8	12/06
26	8.1	14.0	10.6	5	1.0	12/02	8.6	1.0	11/25
27A*	10.1	10.1	10.1	10	1.0	12/02	7.2	1.2	12/06
27B**	4.7	6.5	5.3	0	0.4	12/22	4.1	0.4	12/21
28A	10.0	9.9	8.0	0	0.8	12/02	8.0	0.8	12/02
28B	9.0	9.3	7.8	0	0.6	12/22	6.4	1.6	12/14
29A	9.0	9.9	9.5	10	0.9	12/02	8.5	1.4	12/06
29B	7.0	4.5	5.4	0	1.0	12/12	4.9	0.4	12/22
30A	11.2	12.0	11.4	30	1.1	12/02	11.0	1.2	11/25
30B	8.0	5.7	6.0	0	1.5	12/14	4.6	0.9	12/12
31A	9.9	10.5	8.7	0	0.9	11/28	7.7	0.7	12/02
31B	7.1	6.5	6.3	0	0.5	12/22	5.7	1.1	12/12
32	15.2	19.9	17.2	70	1.3	12/22	16.5	1.6	12/02
32B	10.3	9.1	9.7	14	1.9	12/12	8.1	0.6	12/22
33A	10.5	13.3	11.6	50	1.1	11/30	10.6	1.1	12/05
33B	7.0	10.1	8.4	0	2.1	12/14	7.2	1.7	12/20
ODD***	12.4	15.1	13.7	47	--	12/22	10.8	--	12/19

* "A" suffix indicates sampled first 10 days.
** "B" suffix indicates sampled last 10 days.
*** State's permanent monitor at Odd Fellows Hall, 115½ Ninth Street.
1 Frequency of AVC's exceeding 9 ppm, expressed as a percentage of the number of samples.
2 Ratio of maximum AVC to the eight-hour average for the same time at the State site.
3 Ratio of second-highest AVC to the eight-hour average for the same time at the State site.

Boise Carbon Monoxide
November 25 to December 22, 1977
(Weekdays Only)

Figure 3
Characteristics of Weekday Carbon Monoxide Average Concentrations for an Eight-Hour Period (10:00 A.M. to 6:00 P.M.) at Each Site.

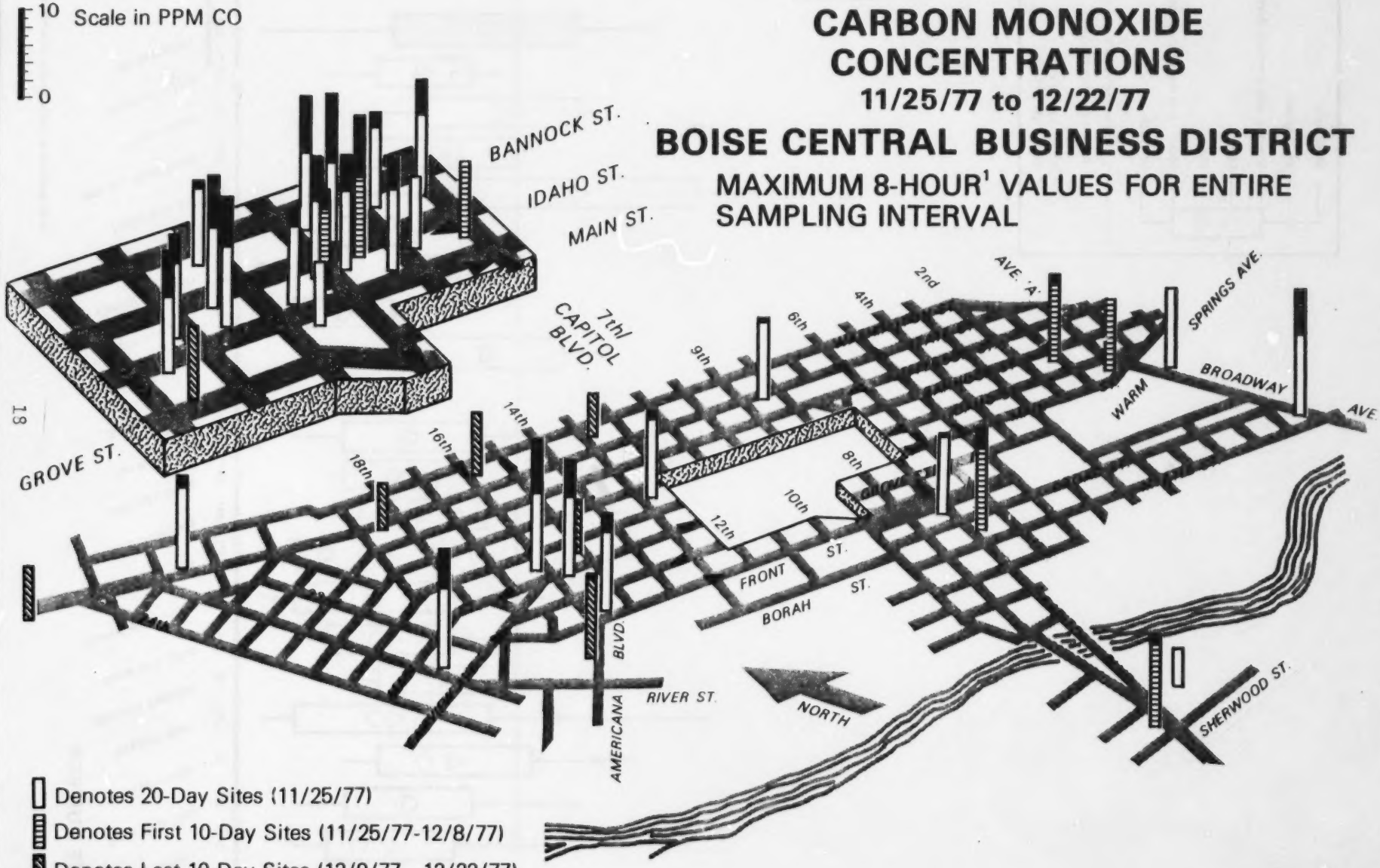




Note: Number of successful samples varies from site to site

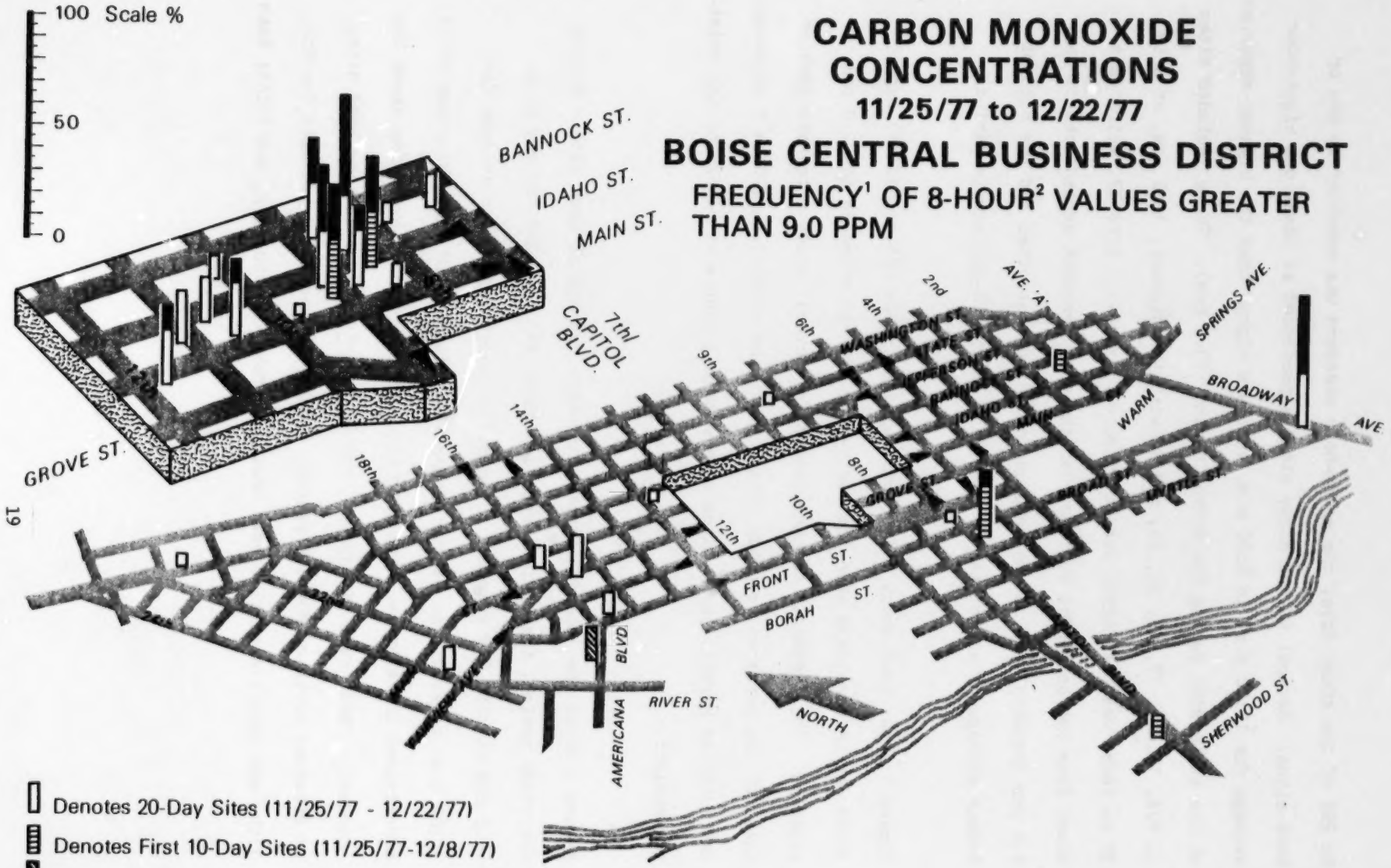
FIGURE 4

CARBON MONOXIDE CONCENTRATIONS
11/25/77 to 12/22/77
BOISE CENTRAL BUSINESS DISTRICT
MAXIMUM 8-HOUR[1] VALUES FOR ENTIRE SAMPLING INTERVAL



[1]10 AM TO 6 PM

FIGURE 5


100 Scale %
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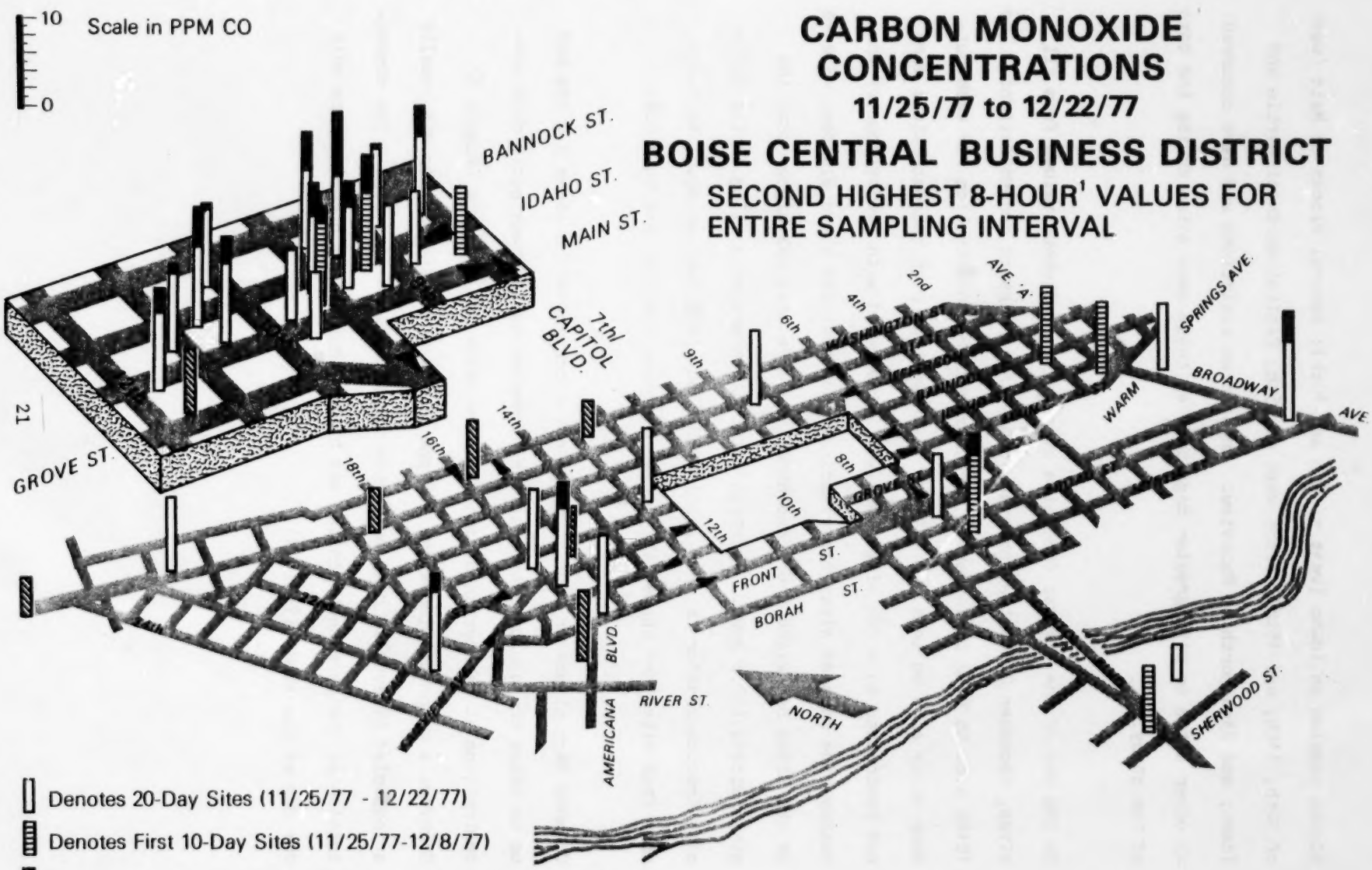
0
CARBON MONOXIDE CONCENTRATIONS
11/25/77 to 12/22/77
BOISE CENTRAL BUSINESS DISTRICT
FREQUENCY[1] OF 8-HOUR[2] VALUES GREATER THAN 9.0 PPM
BANNOCK ST.
IDAHO ST.
MAIN ST.
GROVE ST.
7th/ CAPITOL BLVD.
9th
6th
4th
2nd
AVE. A
WASHINGTON ST.
STATE ST.
JEFFERSON ST.
BANNOCK ST.
IDAHO ST.
MAIN ST.
SPRINGS AVE.
BROADWAY
WARM
AVE
14th
16th
18th
8th
10th
12th
GROVE ST.
BROAD ST.
MYRTLE ST.
FRONT ST.
BORAH ST.
BLVD.
AMERICANA
RIVER ST
NORTH
SHERWOOD ST
Denotes 20-Day Sites (11/25/77 - 12/22/77)
Denotes First 10-Day Sites (11/25/77-12/8/77)
Denotes Last 10-Day Sites (12/9/77 - 12/22/77)
Black Denotes Frequencies Greater than 25%
[1]ROUNDED TO NEAREST 5%
[2]10 AM TO 6 PM

On 95% of the study days, the eight-hour standard was exceeded at one or more sites. Several of the study sites experienced at least one eight-hour average for 10:00 a.m. to 6:00 p.m. that was higher than the highest observed at the state site during the survey period (13.7 ppm). These included sites 1, 10A, 11, 13, 17, 18, 20, 24, and 32 with the highest, 17.2 ppm, at site 32 on Idaho west of Eighth Street (Figures 3 and 4). Site 32, which is a block from the permanent monitor, had the most frequent exceedences of the 9.0 ppm standard (70% of the sampled days) and most often had the highest 8-hour average of all sites (on nine days of the 20-day sample period).

Figure 5 shows that about 70% of the sampling sites (28 out of 40) experienced one or more days when the eight-hour average exceeded the 9.0 ppm standard. The frequency of exceedences for several study sites was greater than for the permanent monitor (47%). With the exception of Site 1 on Broadway north of Myrtle, these sites were within a couple of blocks of the existing monitor.

Figure 6 shows the second-highest eight-hour average at each site. During the study period, the maximum second-highest AVC recorded for any site, 16.5 ppm at site 32, exceeded the second-highest eight-hour average for 10:00 a.m. to 6:00 p.m. at the permanent monitor, 10.8 ppm. Nineteen sites experienced at least two days with an eight-hour period averaging above the standard. These were widespread through the study area and included sites on Broadway north of Myrtle; several blocks between Idaho and Main (on 9th, 11th, and 16th); several blocks north of Idaho (on 8th, 9th, and 10th); both

FIGURE 6


10
Scale in PPM CO
0
CARBON MONOXIDE CONCENTRATIONS
11/25/77 to 12/22/77
BOISE CENTRAL BUSINESS DISTRICT
SECOND HIGHEST 8-HOUR[1] VALUES FOR ENTIRE SAMPLING INTERVAL
BANNOCK ST.
IDAHO ST.
MAIN ST.
21
GROVE ST.
7th/ CAPITOL BLVD.
9th
6th
4th
2nd
AVE. A
SPRINGS AVE.
BROADWAY
AVE.
WARM
14th
16th
18th
8th
10th
12th
FRONT ST.
BORAH ST.
BLVD
AMERICANA
RIVER ST.
NORTH
SHERWOOD ST.
Denotes 20-Day Sites (11/25/77 - 12/22/77)
Denotes First 10-Day Sites (11/25/77-12/8/77)
Denotes Last 10-Day Sites (12/9/77 - 12/22/77)
Black Denotes Values Greater than 9 PPM CO
[1]10 AM TO 6 PM

blocks sampled on Idaho (west of 8th and 10th); several blocks on Main (west of 10th, 11th, and 15th); Front west of 15th; Capitol north of Myrtle and Idaho; and 23rd north of Fairview. Undetected violations may have occurred at other sites or with greater magnitude at these same sites during the days of the study.

On the day of the highest composite average of eight-hour values from all sites, December 2, most sites experienced their highest concentrations. The 10:00 a.m. to 6:00 p.m. average carbon monoxide concentration for each outdoor study site on this day (Figure 7) shows that high concentrations were not restricted to a few sites, but were widespread with twenty-four of the twenty-nine sampled sites experiencing concentrations above 9.0 ppm. Eleven of the sites had eight-hour concentrations more than 20% higher than the state site's (10.5 ppm). Fourteen sites had averages similar to the state site (ratios greater than or equal to 0.8 but less than or equal to 1.2); only four sites had appreciably lower averages (ratios less than 0.8).

On some days at one or more study sites, a concentration above 9.0 ppm and up to twice the concentration at the permanent monitor was noted when concentrations at the permanent monitor were below the standard (Figure 8). However, a concentration above 9.0 ppm at the permanent monitor was usually accompanied by equally high or higher concentrations elsewhere. The concentration at the permanent monitor was higher than at any other site on only one day of the study (Table 3).

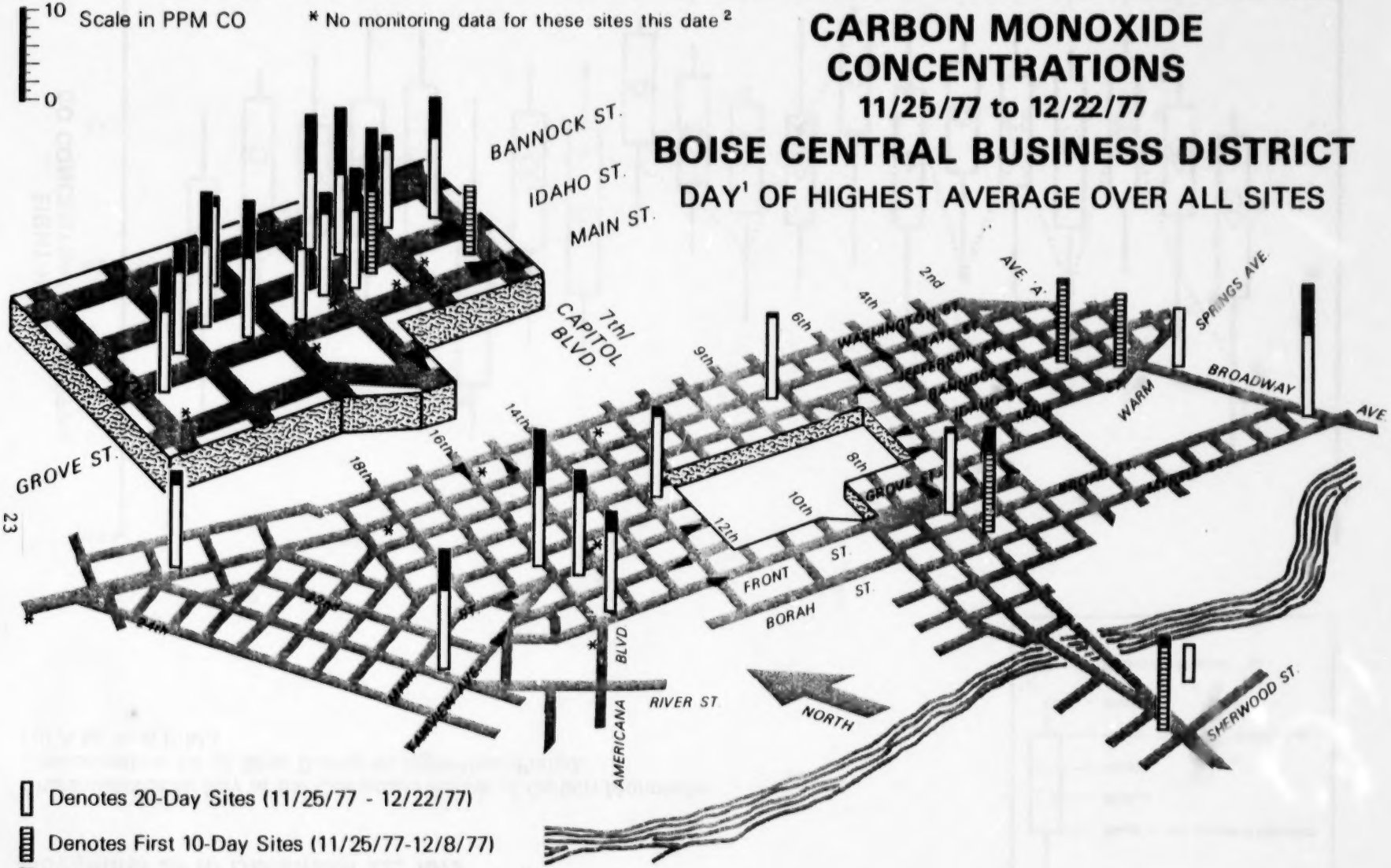
FIGURE 7

CARBON MONOXIDE CONCENTRATIONS

11/25/77 to 12/22/77

BOISE CENTRAL BUSINESS DISTRICT

DAY[1] OF HIGHEST AVERAGE OVER ALL SITES



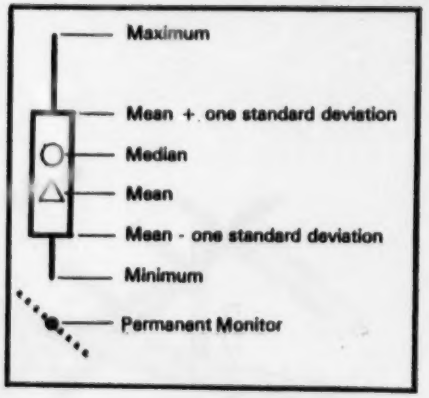
[1] 10 AM TO 6 PM

[2] 12/2/77

FIGURE 8

Boise Carbon Monoxide
November 25 to December 22, 1977

Characteristics by Day of the Composite Range of Carbon Monoxide Concentrations for all Sites During an Eight-Hour Period. (10 A.M. to 6 P.M.)



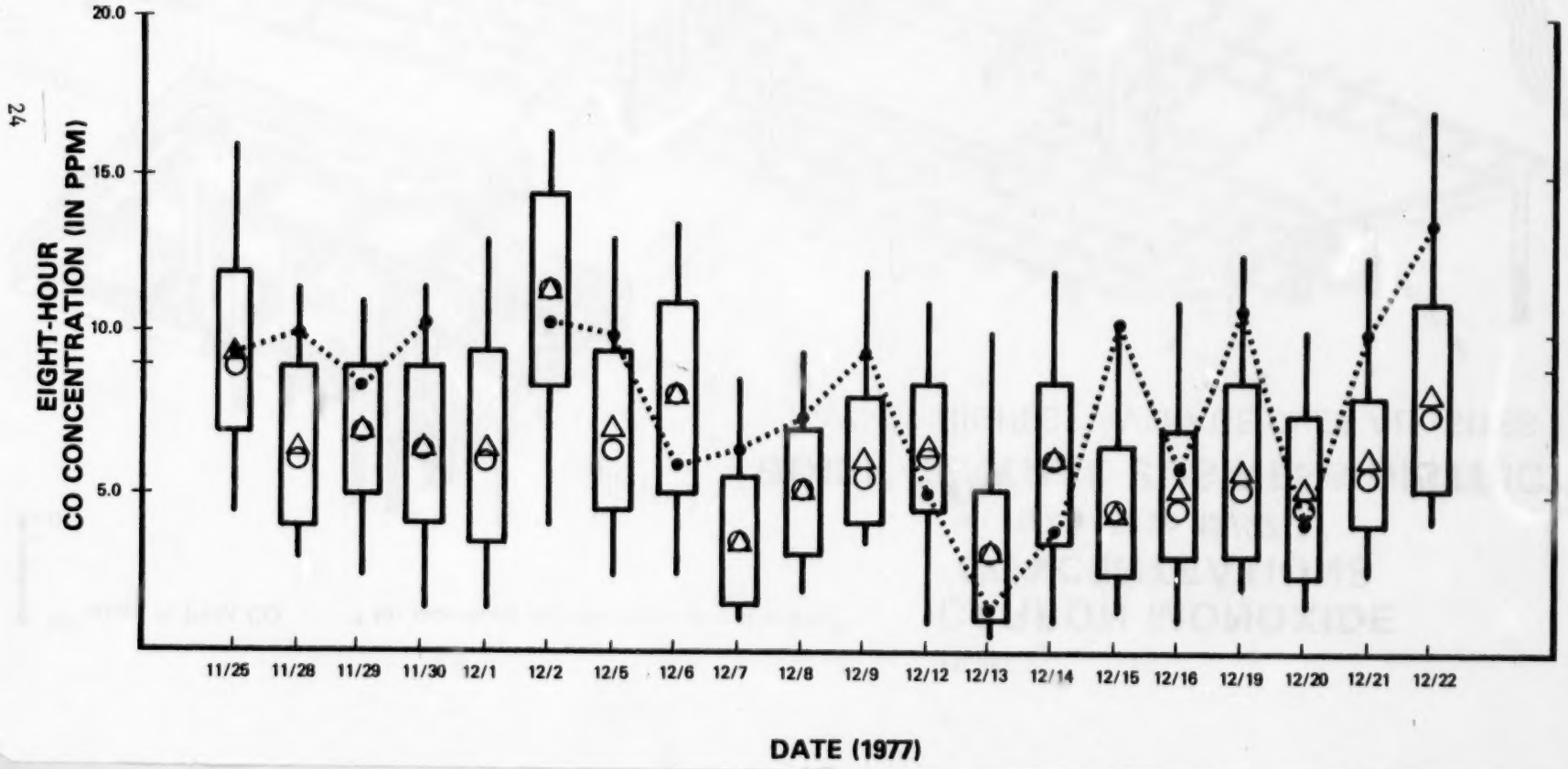


Table 3

Comparison of Maximum Study Site Each Day and Permanent Monitor Eight-Hour Averages
(carbon monoxide in ppm)

1977 Date	STUDY SITES Maximum Study Site	Maximum AVC*	Ratio AVC/AVS**	PERMANENT MONITOR AVS***	Maximum Eight-Hour	End Hour
11/25	32	16.2	1.8	8.8	9.3	1500
28	32	11.3	1.2	9.8	10.7	1600
29	1	11.0	1.3	8.3	8.3	1800
30	33A	11.6	1.1	10.7	10.7	1800
12/01	23	13.0	-	-	-	-
02	32	16.5	1.6	10.5	10.5	1800
05	10A	13.2	1.3	9.9	9.9	1900
06	11	13.3	2.2	6.2	6.2	1800
07	32	8.7	1.4	6.4	7.4	1500
08	13	9.4	1.2	7.6	8.2	2000
09	32	12.1	1.2	9.7	9.7	1800
12	1	11.1	2.1	5.2	8.4	1500
13	11	9.8	7.8	1.3	2.8	0100
14	11	11.9	3.0	4.0	4.0	1800
15	32	9.9	.9	10.7	10.7	1800
16	32	11.0	1.8	6.0	6.4	1500
19	13	12.4	1.1	10.8	12.0	1900
20	20 and 11	10.1	2.4	4.1	7.1	1400
21	32	12.6	1.2	10.2	10.5	2000
22	32	17.2	1.3	13.7	13.7	1900

* Eight-hour average CO concentration for 10:00 a.m. - 6:00 p.m. (1000 - 1800) at a study site

** Ratio AVC/AVS - The ratio of the eight-hour average CO concentration at the study site to that at the permanent monitor on the same day for the 10:00 a.m. - 6:00 p.m. period.

*** Eight-hour average CO concentration for 10:00 a.m. - 6:00 p.m. at the permanent monitor operated by the State at 115½ Ninth Street.

The study ended on Thursday, December 22, the day before the highest eight-hour average for 1977 was recorded at the permanent monitor - 18.5 ppm ending at 6:00 p.m. Based on data collected during the study, it seems highly likely that concentrations greater than this occurred at one or more study sites on Friday, December 23.

Indoor Sites

At all six indoor sites, the concentrations were usually less than at the adjacent outdoor sites. Otherwise, no consistent relationship between indoor and outdoor levels was noted in this limited study. Nevertheless, the eight-hour average concentrations on one or more days exceeded 9.0 ppm at four of the indoor locations with maximum values ranging from 10.0 to 11.1 ppm. At several sites, late afternoon increases in indoor CO were observed, suggesting an influence from the afternoon peak traffic.

Pedestrian Data

Sampling periods ranged in length from about two to four hours on two routes which varied from day to day. For these samples, concentrations ranged from 3.9 ppm to 14 ppm. On four days, the average of morning and afternoon samples totalling about seven or more hours was equal to or above 9.0 ppm.

Correlations were examined between concentrations on Route A and those on Route B and were surprisingly high. Better correlations were found between the different routes on the same day than between morning and afternoon samples from the same route.